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Jin

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(54) **REFRIGERANT COMPENSATOR**

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F25B 13/00 (2006.01)

(52) **U.S. Cl.**
USPC **62/430**; 62/324.4

(58) **Field of Classification Search**
USPC 62/77, 324.4, 292, 473, 196.3
See application file for complete search history.

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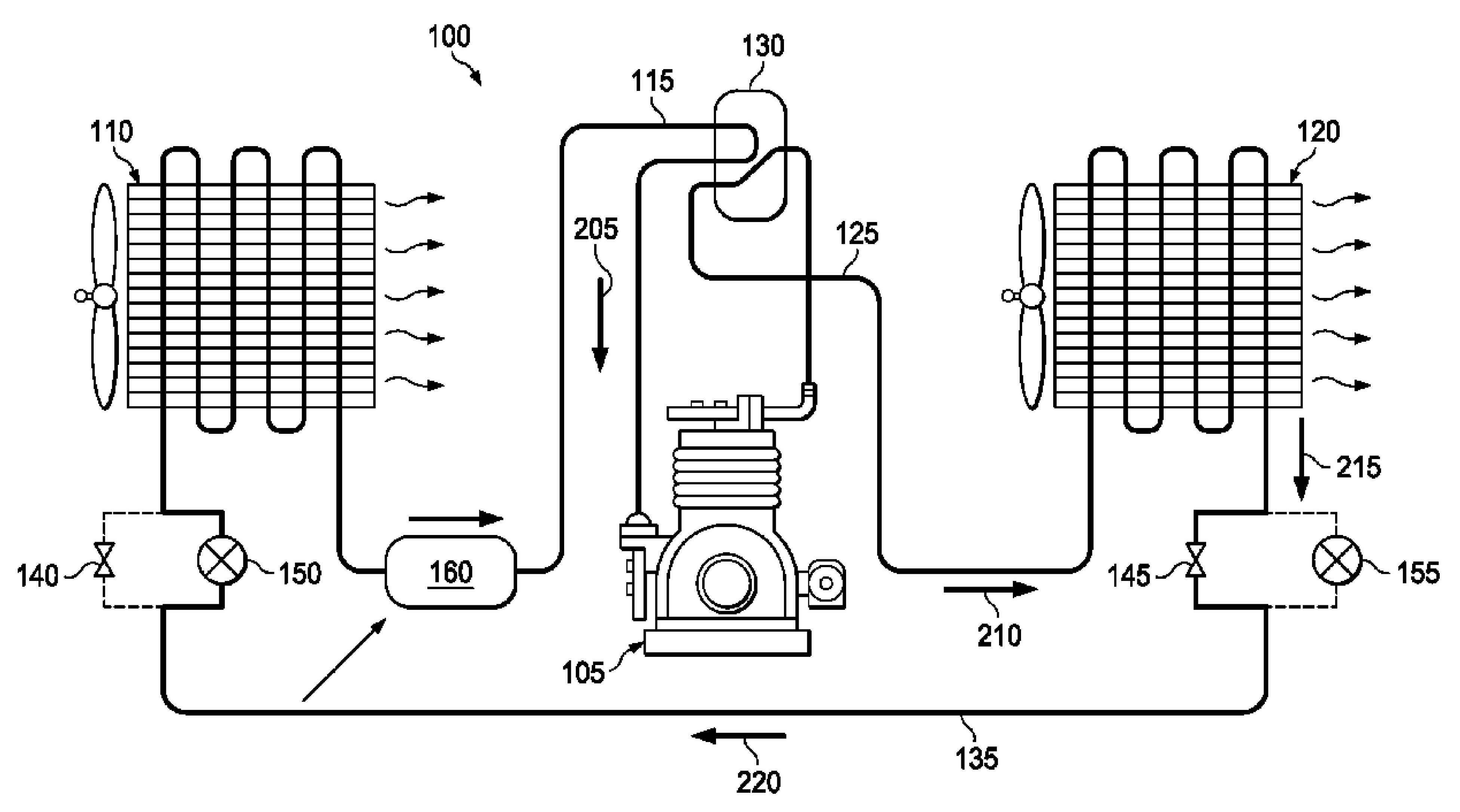
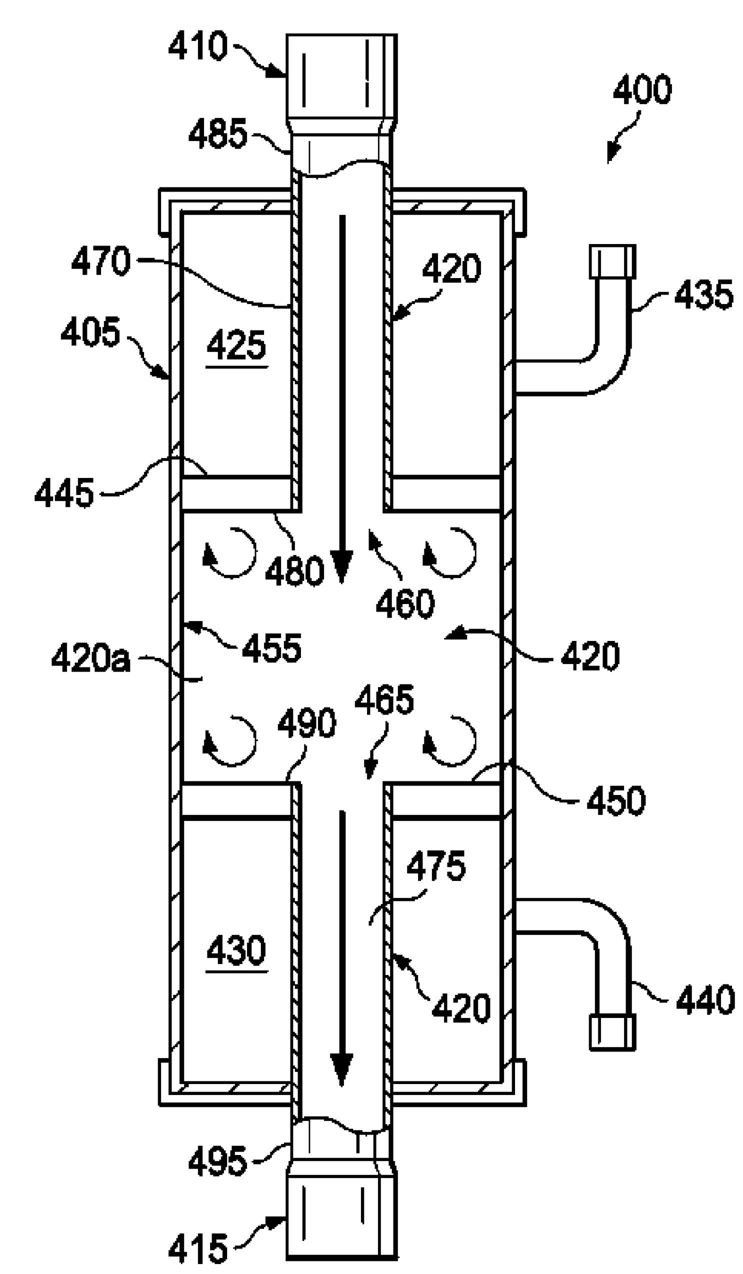
(57) **ABSTRACT**

One aspect of this disclosure provides a refrigerant charge compensator having an increased heat transfer surface. The housing has an internal volume and first and second ports for allowing a passage of refrigerant therethrough. The internal volume is partitioned into an indirect refrigerant passageway that extends through the housing and a refrigerant storage area. The refrigerant storage area has a storage access port and is in contact with the indirect refrigerant passageway. Also a heat pump system implementing the compensator is provided and a method of manufacturing the compensator is provided.

5 Claims, 6 Drawing Sheets





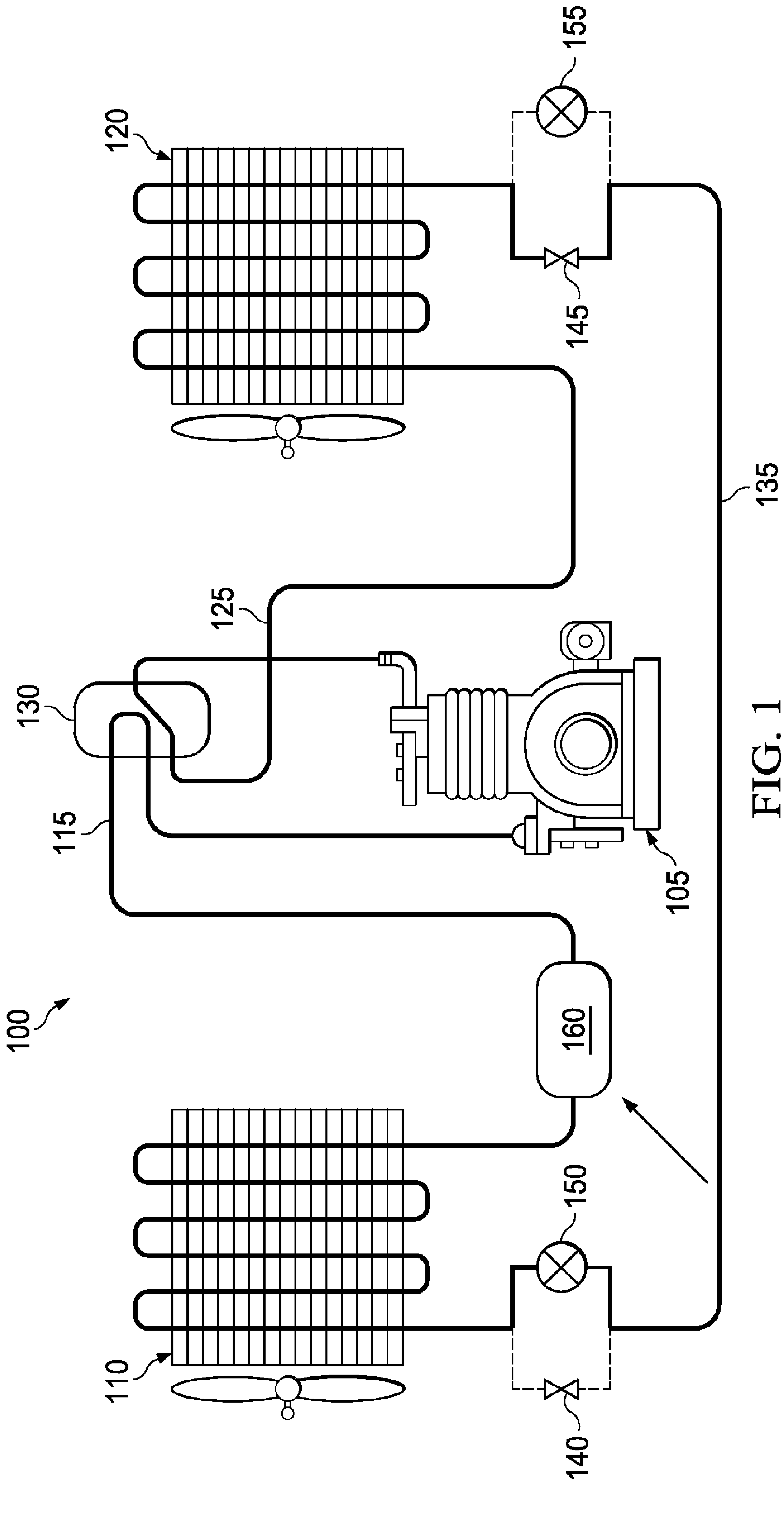


FIG. 1

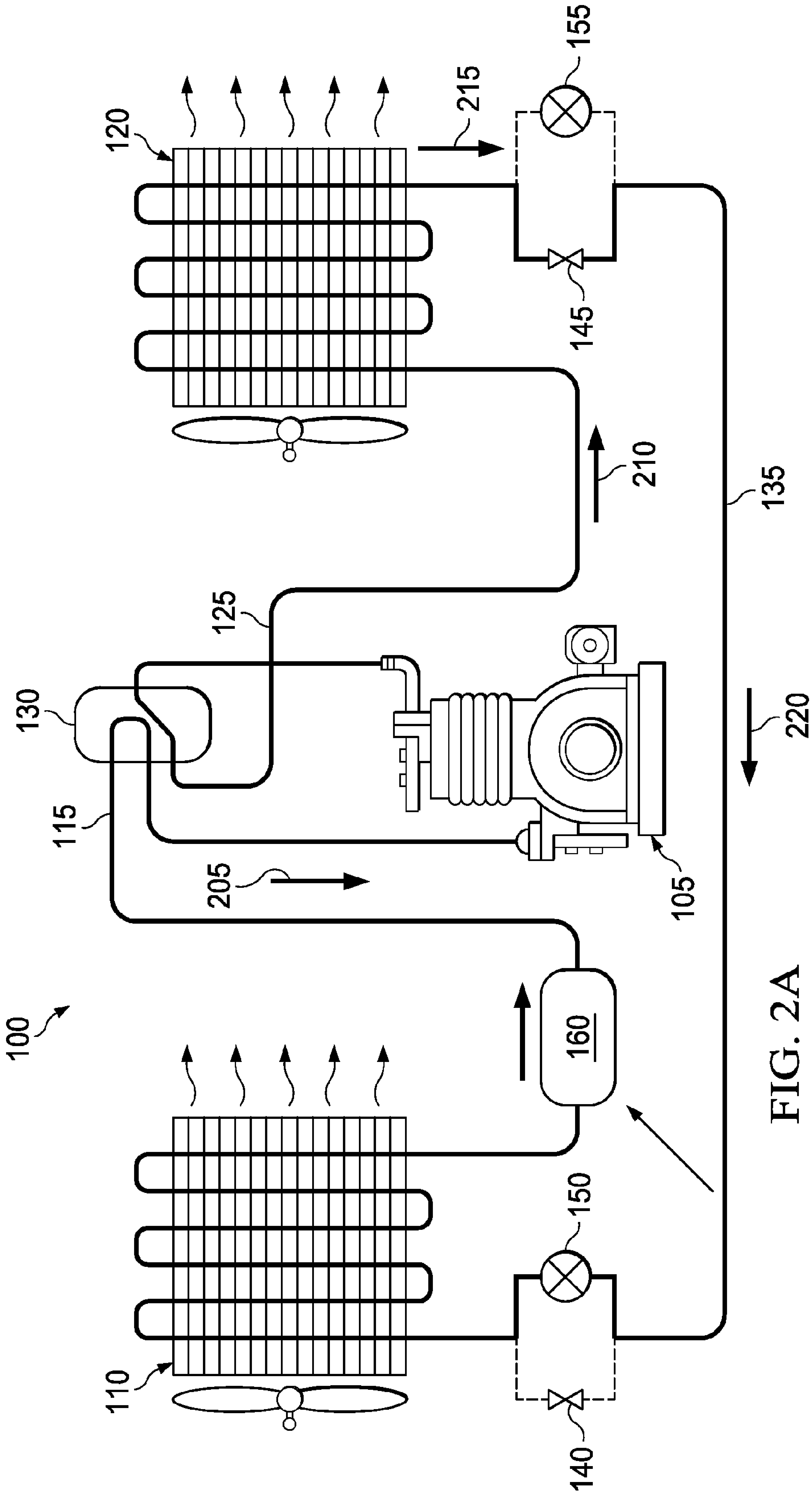

100
105
110
115
120
125
130
135
140
145
150
155
160
205
210
215
220

FIG. 2A

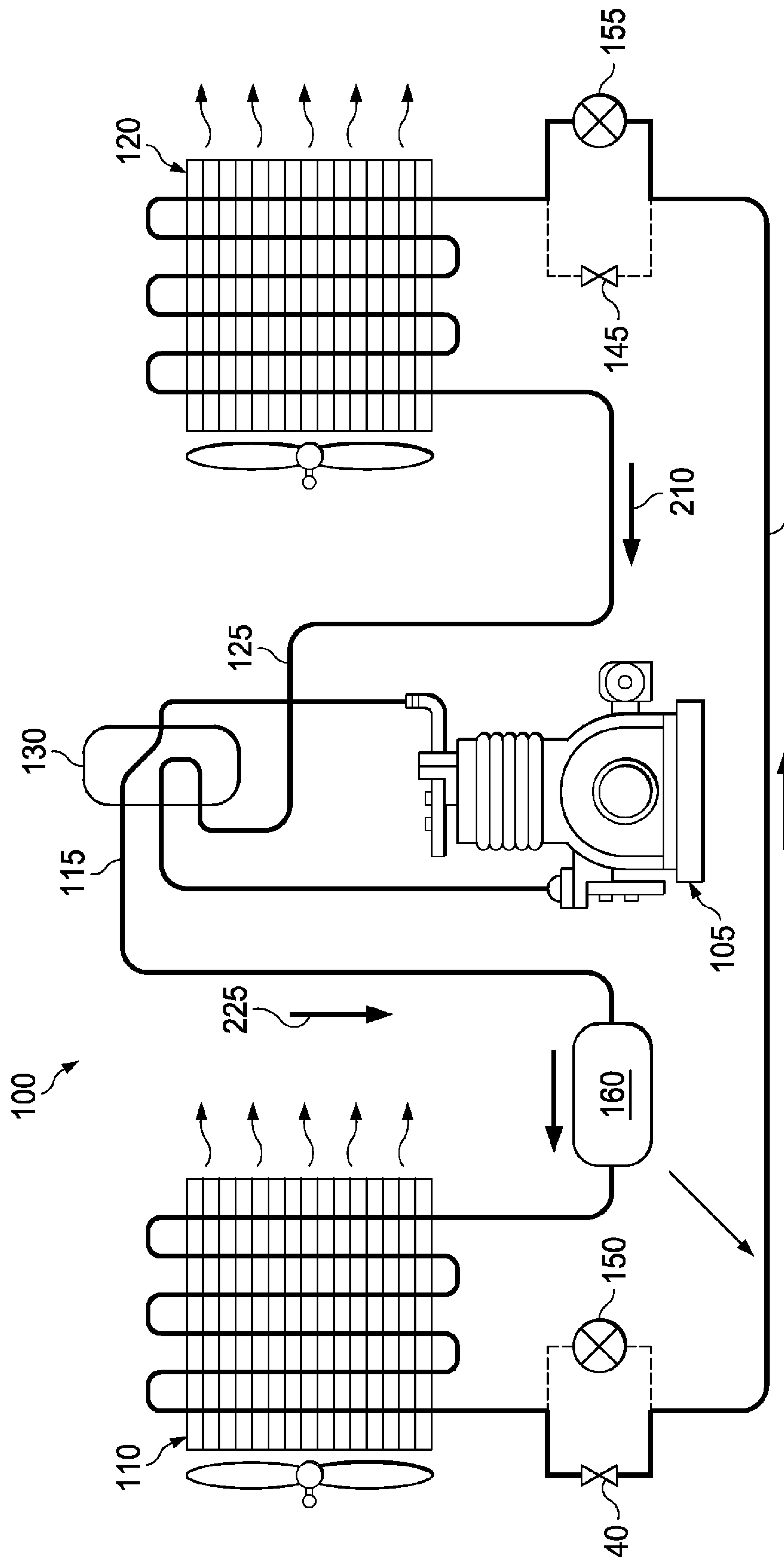


FIG. 2B

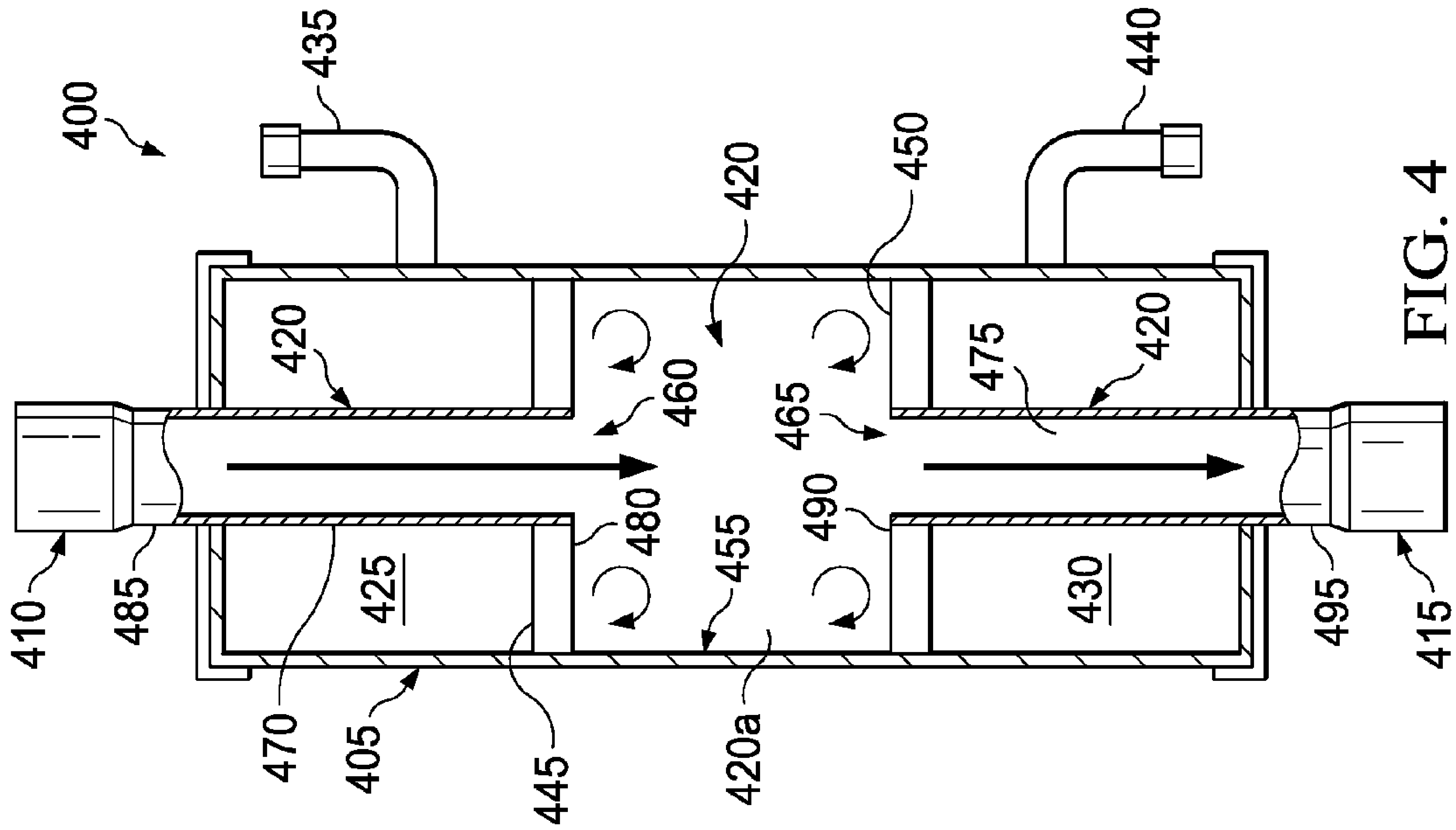

400
435
440
420
450
420
420
475
460
465
480
490
455
425
430
410
485
495
415
470
405
445
420a

FIG. 4

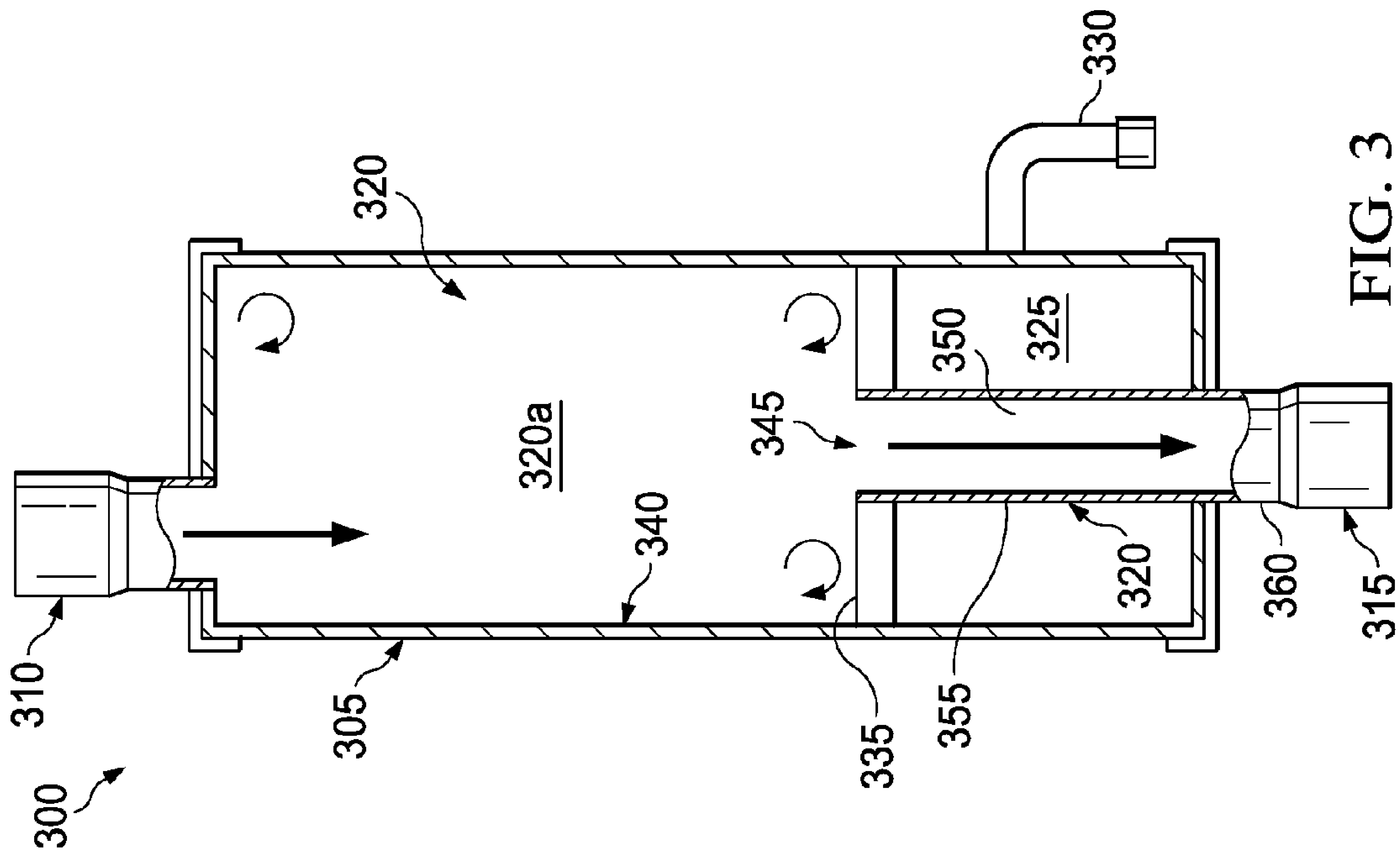

330
320
350
325
345
320a
340
320
310
305
335
355
360
315
300

FIG. 3

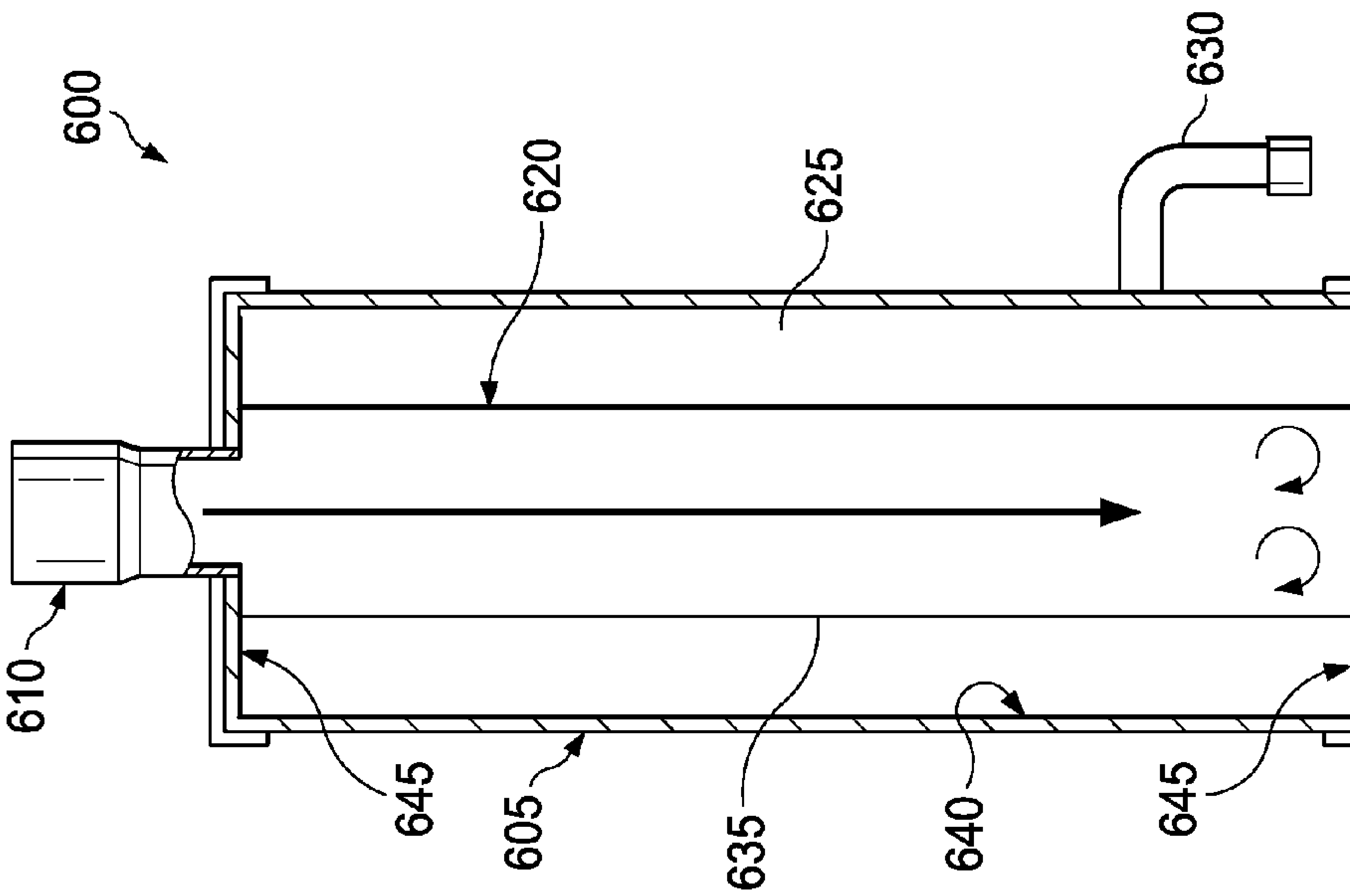

600
610
615
620
625
630
635
640
645
605
645

FIG. 6

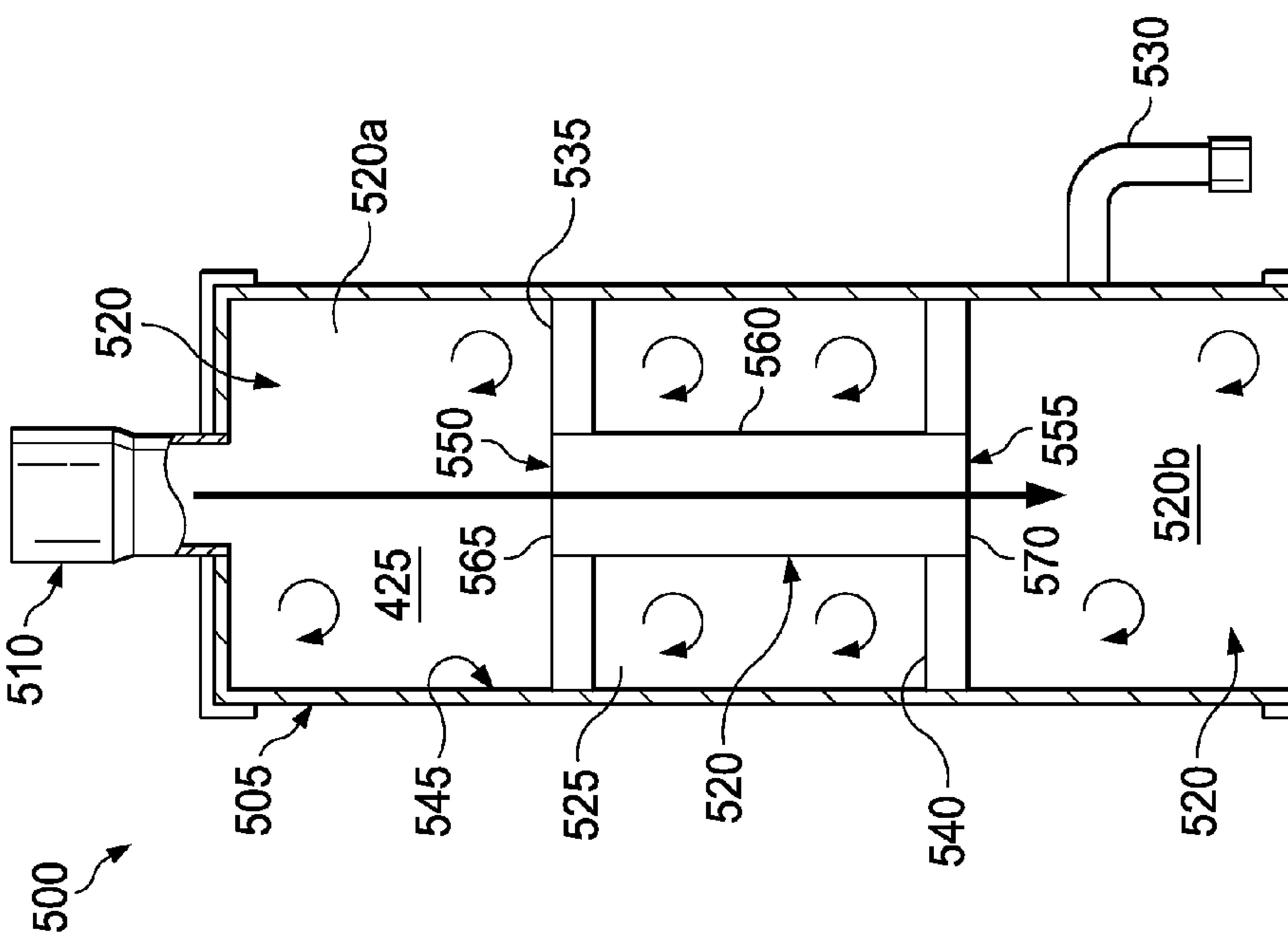

500
505
510
515
520
520a
520b
425
525
530
535
540
545
550
555
560
565
570
520
520

FIG. 5

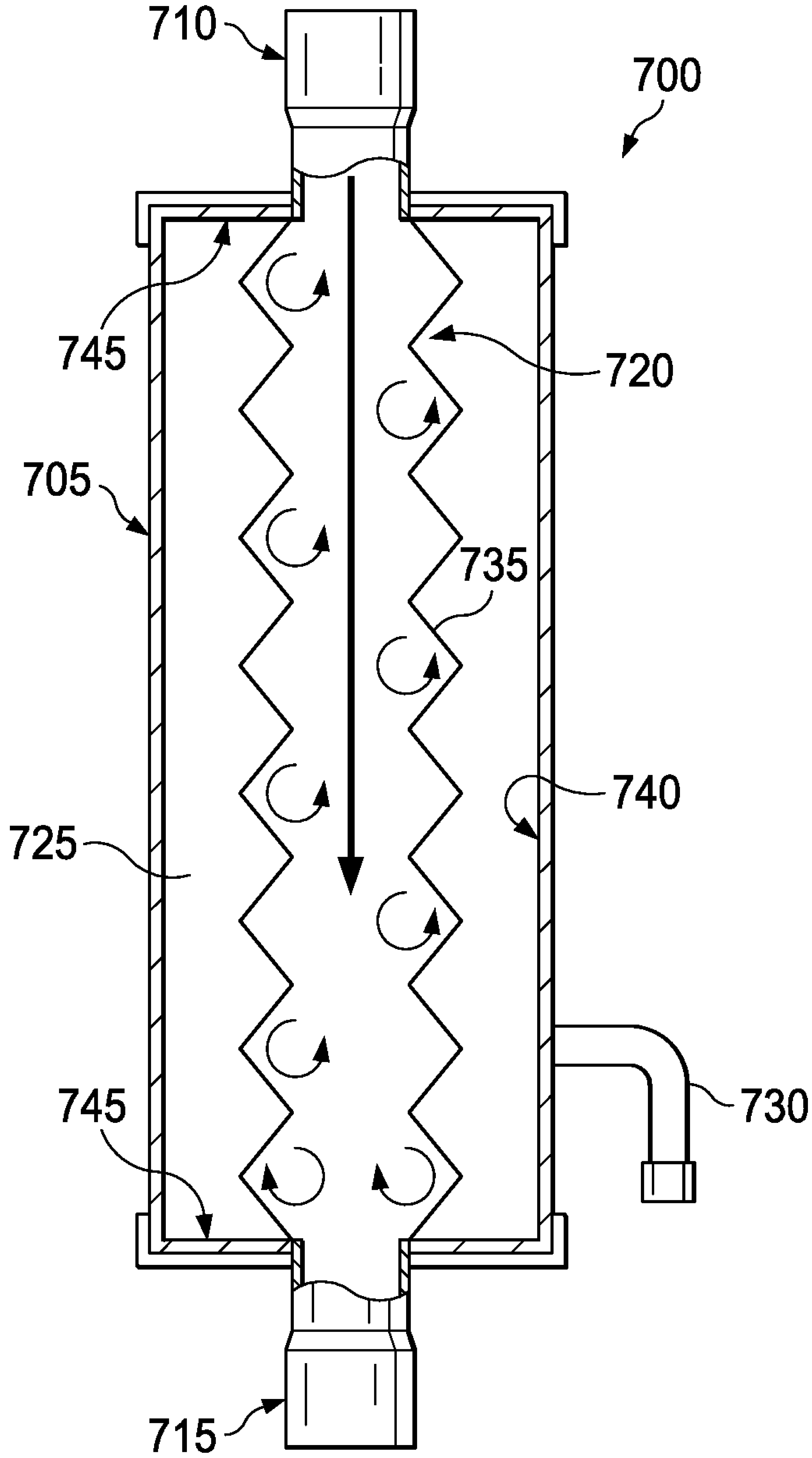


FIG. 7

REFRIGERANT COMPENSATOR

TECHNICAL FIELD

This application is directed, in general, to a refrigerant compensator that may be used in a heating ventilation and air conditioning system.

BACKGROUND

In heat pump systems, existing refrigerant compensators are able to adjust refrigerant charge to accommodate different amounts of refrigerant that are needed during heating and cooling cycles. Since the optimum refrigerant charge during the cooling mode is different from the refrigerant charge during the heating mode, it is necessary to adjust the refrigerant charge to get better performance at the respective operating modes for heat pump applications. Existing charge compensators comprise a tank with a vapor tube passing directly through the tank. In the cooling mode, sub-cooled liquid refrigerant further cools down and is stored in the compensator due to heat transfer because the temperature of the refrigerant vapor passing through the compensator is lower than the sub-cooled liquid refrigerant. Conversely, in the heating mode, stored refrigerant is driven from the compensator because the stored refrigerant absorbs heat from the higher temperature vapor passing through the compensator.

SUMMARY

One aspect of this disclosure provides a refrigerant charge compensator having an increased heat transfer surface. This embodiment comprises a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough. The internal volume is partitioned into an indirect refrigerant passageway that extends through the housing and a refrigerant storage area. The refrigerant storage area has a storage access port and is in contact with the indirect refrigerant passageway.

In another aspect a heat pump system is disclosed. This embodiment comprises a compressor, an inside heat exchanger in fluid connection with the compressor by a first refrigerant line, an outside heat exchanger in fluid connection with the compressor by a second refrigerant line, and a compensator in fluid connection with the first refrigerant line and interposed the inside heat exchanger and the compressor. In this embodiment, the compensator comprises a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough. The internal volume is partitioned into an indirect refrigerant passageway that extends through the housing and a refrigerant storage area. The refrigerant storage area has a storage access port and is in contact with the indirect refrigerant passageway. The heat pump system further comprises a third refrigerant flow line fluidly connecting the inside heat exchanger and the outside heat exchanger. The third refrigerant line has first and second bypass valves and thermal expansion valves connected thereto and interposed the inside heat exchanger and said outside heat exchanger. The refrigerant storage area is in fluid connection with the third refrigerant flow line through the storage access port.

In another embodiment, a method of manufacturing a compensator for a heat pump unit is provided. This embodiment comprises forming a housing having an internal volume, forming first and second ports in the housing for allowing a passage of refrigerant therethrough, partitioning the internal volume into an indirect refrigerant passageway that extends through said housing, and a refrigerant storage area that is in contact with the indirect refrigerant passageway, and forming a storage access port in the housing to access the refrigerant storage area.

BRIEF DESCRIPTION

Reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a heat pump system implementing the compensator as disclosed herein;

FIG. **2**A-**2**B illustrate the heat pump system of FIG. **1** in a cooling mode and heat mode, respectively;

FIG. **3** illustrates a sectional view of one embodiment of the compensator as provided herein;

FIG. **4** illustrates a sectional view of another embodiment of the compensator as provided herein;

FIG. **5** illustrates a sectional view of another embodiment of the compensator as provided herein;

FIG. **6** illustrates a sectional view of another embodiment of the compensator as provided herein; and

FIG. **7** illustrates a sectional view of another embodiment of the compensator as provided herein.

DETAILED DESCRIPTION

FIG. **1** illustrates an embodiment of a heat pump system **100** in which various embodiments of the compensator, as described herein, may be employed. In the embodiment illustrated in FIG. **1**, the heat pump system **100** comprises a compressor unit **105** that is fluidly connected to an inside heat exchanger **110** by a first refrigerant line **115** and is fluidly connected to an outside heat exchanger **120** by a second refrigerant line **125**. As used throughout this disclosure and in the claims, fluidly connected means that system is capable of transmitting a refrigerant fluid from one component to another. The term does not necessitate the presence of the fluid or vapor, neither does it exclude it. A reversing valve **130** allows the direction of the refrigerant flow to be reversed, depending on which cycle is being implemented. The inside and outside heat exchangers **110**, **120** are fluidly connected by a third refrigerant line **135** and include a pair of bypass valves **140**, **145** and thermal expansion valves, **150**, **155** located between the inside and outside heat exchangers **110**, **120**. The above discussed components may all be of conventional design.

The heat pump system **100** further includes an improved compensator **160**, embodiments of which are described below. The compensator **160** is interposed the compressor unit **105** and the inside heat exchanger **100** and is fluidly connected to the first refrigerant line **115** and to the third refrigerant line **135**. Details of the way in which the compensator **160** is connected to the first and third refrigerant lines **115**, **135** are described below.

FIGS. **2**A and **2**B illustrate the heat pump system **100** in a cooling mode and a heating mode, respectively. During the cooling mode, which is shown in FIG. **2**A, refrigerant vapor **205** enters the compressor **105** where it is compressed and exits the compressor **105** as a superheated vapor **210**. The superheated vapor **210** travels through the refrigerant line **125** to the outside heat exchanger **120**. The superheated vapor **210** then traverses the outside heat exchanger **120**, which first cools and removes the superheat, and then condenses the vapor into a sub-cooled liquid refrigerant **215** by removing additional heat at substantially constant pressure and temperature. The sub-cooled liquid refrigerant **215** goes through the bypass valve **145** and the sub-cooled liquid **220** travels through refrigerant line **135** where a portion of the sub-cooled liquid **220** is drawn into a storage area located within the compensator **160** through a storage access port. The remaining sub-cooled liquid **220** then proceeds through the thermal expansion valve **150** where its pressure abruptly decreases and the refrigerant vapor quality at the inlet of the inside heat exchanger **110** is about 20% and to the inside heat exchange **110** where it is completely vaporized by cooling the warm air (from the space being refrigerated) being blown by a fan across the inside heat exchanger **110**. The resulting superheated refrigerant vapor then travels through the refrigerant passageway in the compensator **160** and the refrigerant line **115** and to the compressor **105** to complete the thermodynamic cycle.

Due to the temperature difference (which can vary as much as 30° F. to 70° F.) between the sub-cooled refrigerant liquid in the storage area and the refrigerant vapor passing through the refrigerant passageway within the compensator **160**, the sub-cooled liquid is cooled further, which allows additional refrigerant liquid to be stored within the storage area of the compensator **105**.

In conventional designs, the refrigerant passageway goes directly through the compensator, which limits the surface area for heat transfer purposes. However, as described below, embodiments of the compensator **160** of the present disclosure provide the improved heat transfer surface area by providing an indirect refrigerant flow path through the compensator **160** and increases the efficiency of the compensator's operation.

FIG. **2**B illustrates the heat pump **100** in a heating mode. During the heating mode, the reversing valve **130** is engaged, which reverses the above described process. In this mode, refrigerant vapor enters the compressor **105** where it is compressed and exits the compressor **105** as a superheated vapor **225**. The superheated vapor **225** travels through the refrigerant line **115** and through the compensator **160** by way of the refrigerant passageway within the compensator **160**. At this point the superheated vapor **225** transfers heat through the increased surface area of the refrigerant passageway within the compensator **160** and heats the sub-cooled liquid stored in the storage area of the compensator **160**, which causes it to be driven out by way of the storage access port and into refrigerant line **135**. The superheated vapor travels **225** on to the inside heat exchanger **110**, which first cools and removes the superheat and then condenses the vapor into a sub-cooled liquid by removing additional heat at substantially constant pressure and temperature. The removed heat is transferred from the inside heat exchanger **110** into the space intended to be heated by a fan. The sub-cooled liquid refrigerant goes through the bypass valve **140**, and the sub-cooled liquid **230** travels through refrigerant line **135** where a portion of the vaporized sub-cooled liquid is drawn back into the refrigerant line **135** from the storage area located within the compensator **160**, thereby increasing the amount of refrigerant vapor in the refrigerant line **135**. The sub-cooled liquid vapor mixture then proceeds through the thermal expansion valve **155** where its pressure abruptly decreases and the refrigerant vapor quality at the inlet of the outside heat exchanger **110** is about 20% and to the outside heat exchange **120** where it is further vaporized. The resulting refrigerant vapor then travels through the refrigerant passageway **125** and to the compressor **105** to complete the thermodynamic cycle.

The driving force of the refrigerant change adjustment is based on heat transfer between the vapor refrigerant passing through the compensator **160** and the sub-cooled liquid refrigerant stored in the storage area of the compensator **160**. Because the compensator, as disclosed herein, provides additional surface area for heat transfer within the compensator, more refrigerant liquid can be stored in the compensator **160**. This improvement makes more refrigerant vapor available during for the heating mode, which in turn, increases the efficiency of the operation of heat pump system **100**.

FIG. **3** illustrates a sectional view of one embodiment of the compensator **160** of FIG. **1**. In this particular embodiment, compensator **300** includes a housing **305**, which is appropriately constructed of a material, such as metal, that is able to withstand the operating pressures of a heat pump system. The housing **305** is hollow and has an internal volume and further includes first and second ports **310**, **315** for allowing a passage of refrigerant through the housing **305**. As seen in this embodiment, one or both of the ports may be off-centered with respect to the housing **305**, which provides the advantage of preventing compressor lubricant from being stored in the housing **305**. The first and second ports **310**, **315** may either be exit ports or entry ports, depending on the operational mode of the heat pump system to which the compensator **300** is connected. The ports **310**, **315** may have different configurations, depending on the embodiment. For example, the ports **310**, **315** may be a separate connection nipple that may be welded to an opening in the housing **305**, or it may be the opening itself, or alternatively, it may be an extension of a refrigerant passageway that extends outwardly from the housing **305**.

The internal volume is partitioned into an indirect refrigerant passageway **320** that extends through the housing **305** and a refrigerant storage area **325**. The refrigerant storage area **325** has a storage access port **330** by which the storage area **325** can be connected to refrigerant line **135** in a manner discussed above regarding FIG. **1**. The storage access area **325** is also in contact with the indirect refrigerant passageway **320**, which allows for heat transfer between the refrigerant storage area **325** and the indirect refrigerant passageway **320**. In this particular embodiment, the partitioning is accomplished by a wall **335** that is attached to an interior surface **340** of the housing **305**. Typically, the wall **335** will be brazed or welded to the interior surface **340** to form a pressure seal between them. The wall **335** has an opening **345** that allows for the passage of the refrigerant. This particular embodiment further comprises a refrigerant tube **350** that is located within the housing **305**. The refrigerant tube **350** has first and second ends **355 360**, wherein the first end **355** is attached to the wall **335** at the opening **345** to form a refrigerant passageway through the wall **335**, and the second end **360** is fluidly connected to the second port **315**. Of course it should be understood that the design could be reversed such that the second end **335** is fluidly connect to the first port **310**. Thus, in this embodiment, the refrigerant passageway **320** comprises an indirect refrigerant passageway chamber **320*a*** that is formed by the partitioned space **320**, and further comprises the refrigerant tube **350**. The volume of the indirect refrigerant passageway chamber **320*a*** is defined by wall **335** and a portion of the housing **305**, as illustrated. This configuration may provide at least about a 27% increase in heat transfer surface area over conventional designs, which allows for improved heat transfer, and thereby, more efficient operation of the heat pump system.

As used in this disclosure and the claims, the word indirect means that a refrigerant, when passed through the compensator, would not take a direct route through the refrigerant passageway in that the refrigerant either encounters one or more walls or surfaces within the housing that are not parallel with the direction of the flow of the refrigerant through the housing. These areas are generally designated in the figures by circular arrows. In other examples, the refrigerant passageway **320** may include a serpentine configuration, such as a corrugated or spiral section. The purpose of the indirect passageway **320** is to provide additional surface area for heat transfer that does not currently exist in conventional compensators. For example, in conventional compensators the refrigerant passageway typically consists of a straight tube that has the same diameter within the housing as it does outside the housing. As a result, the heat transfer surface area is limited to whatever geometry the tube has going into the housing.

FIG. **4** illustrates a sectional view of another embodiment of the compensator **160** of FIG. **1**. In this embodiment, the compensator **400** comprises a housing **405**, which is appropriately constructed of a material, such as metal, that can withstand the operating pressures of a heat pump system. The housing **405** is hollow and has an internal volume and further includes first and second ports **410**, **415** for allowing a passage of refrigerant through the housing **405**. The first and second ports **410**, **415** may either be exit ports or entry ports, depending on the operational mode of the heat pump system to which the compensator **400** is connected. The ports **410**, **415** may also have different configurations, depending on the embodiment. For example, the ports **410**, **415** may be a separate connection nipple that is brazed to an opening in the housing **405**, or it may be the opening itself, or alternatively, it may be an extension of a refrigerant passageway that extends outwardly from the housing **405**, as shown in FIG. **4**.

In the embodiment of FIG. **4**, the internal volume is partitioned into an indirect refrigerant passageway **420** that extends through the housing **405**, and refrigerant storage areas **425** and **430**. Both of the refrigerant storage areas **425**, **430** are in contact with different areas of the indirect refrigerant passageway **420**, as illustrated. Additionally, each of the refrigerant storage areas **425**, **430** has a storage access port **435**, **440**, respectively, which allows the compensator **400** to be connected to the refrigerant line **135** in a manner discussed above regarding FIG. **1**.

In this particular embodiment, the partitioning is accomplished with two spaced apart walls **445** and **450** that are attached to an interior surface **455** of the housing **405**. Typically, the walls **445** and **450** will be brazed or welded to the interior surface **455** to form a seal between them. Each of the walls **445**, **450** have openings **460**, **465**, respectively, that allow for passage of the refrigerant. This particular embodiment further comprises refrigerant tubes **470**, **475** that are located within the housing **405**. The refrigerant tube **470** has first and second ends, **480**, **485**, wherein the first end **480** is attached, typically by welding, to the wall **445** at the opening **450**, and the second end **485** is located outside the housing **405** at the port **410**.

Similarly, the refrigerant tube **475** has first and second ends **490**, **495**, wherein the first end **490** is attached, typically by a welding, to the wall **450** at the opening **465** that forms a refrigerant passageway through the wall **450**, and the second end **495** is located outside the housing **405** at the port **415**.

Thus, in this embodiment, the indirect refrigerant passageway **420** comprises refrigerant tubes **470**, **475** that extend through the storage areas **425**, **430** to the outside of the housing **405** and an indirect refrigerant passageway chamber **420***a* located between the two storage areas **425**, **430**. The volume of the indirect refrigerant passageway chamber **420***a* is defined by the walls **445**, **450** and a portion of the housing **405**, as illustrated. This configuration may provide at least about a 67% increase in heat transfer surface area over conventional designs, which allows for improved heat transfer, and thereby, more efficient operation of the heat pump system.

FIG. **5** illustrates a sectional view of another embodiment of the compensator **160**. In this embodiment, compensator **500** comprises a housing **505**, which is appropriately constructed of a material, such as metal, that can withstand the operating pressures of a heat pump system. The housing **505** is hollow and has an internal volume and further includes first and second ports **510**, **515** for allowing a passage of refrigerant through the housing **505**. The first and second ports **510**, **515** may either be exit ports or entry ports, depending on the operational mode of the heat pump system to which the compensator **500** is connected. The ports **510**, **515** may also have different configurations, depending on the embodiment. For example, in the illustrated embodiment, the ports **510**, **515** are separate connection nipples that are welded to an opening in the housing **505**, as shown in FIG. **5**.

In the embodiment of FIG. **5**, the internal volume is partitioned into an indirect refrigerant passageway **520** that extends through the housing **505**, and a refrigerant storage area **525** that is in contact with the refrigerant passageway **520**, as illustrated. Additionally, the refrigerant storage area **525** has a storage access port **530**, which allows the compensator **500** to be connected to the refrigerant line **135** in a manner discussed above regarding FIG. **1**.

In this particular embodiment, the partitioning is accomplished by two spaced apart walls **535** and **540** that are attached to an interior surface **545** of the housing **505**. The walls **535**, **540** form the storage area **525** between them and also form indirect refrigerant passageway chambers **520***a* and **520***b* on opposing ends of the housing **505**. The volume of each chamber **520***a* and **520***b* is defined by the walls **535** and **540**, respectively, and portions of the housing **505**, as illustrated. Typically, the walls **535** and **540** will be welded to the interior surface **545** to form a seal between them. Each of the walls **535**, **540** have openings **550**, **555**, respectively, that allow for the passage of the refrigerant. The indirect refrigerant passageway **520** further comprises a refrigerant tube **560** that is located within the housing **505** and between the walls **535**, **540**. The refrigerant tube **560** has first and second ends, **565**, **570**, wherein the first end **565** is attached, typically by welding, to the wall **535** at the opening **550** that forms a refrigerant passageway through the wall **535**, and the second end **570** is attached to the wall **540** at the opening **555** that form a refrigerant passageway through the wall **540**. The chambers **520***a* and **520***b* are fluidly connected to the ports **510**, **515**, respectively, as shown in FIG. **5**.

Thus, in this embodiment, the indirect refrigerant passageway **520** comprises indirect refrigerant passageway chambers **520***a*, **520***b* located on opposing ends of the housing **505**, and the refrigerant tube **560** that extends between the two chambers **520***a*, **520***b*. The storage area **525** is located between and in contact with both chambers **520***a*, **520***b* such that heat transfer can occur. This configuration may provide at least about a 67% increase in heat transfer surface area over conventional designs, which allows for improved heat transfer, and thereby, more efficient operation of the heat pump system.

FIG. **6** illustrates a sectional view of another embodiment of the compensator **160**. In this embodiment, the compensator **600** comprises a housing **605**, which is appropriately constructed of a material, such as metal, that can withstand the operating pressures of a heat pump system. The housing **605** is hollow and as an internal volume and further includes first and second ports **610**, **615** for allowing a passage of refrigerant through the housing **605**. The first and second ports **610**, **615** may either be exit ports or entry ports, depending on the operational mode of the heat pump system to which the compensator **600** is connected. The ports **610**, **615** may also have different configurations, depending on the embodiment. For example, in the illustrated embodiment, the ports **610**, **615** are separate connection nipples that are welded to an opening in the housing **605**, as shown in FIG. **6**.

In the embodiment of FIG. **6**, the internal volume is partitioned into an indirect refrigerant passageway **620** that extends through the housing **605**, and a refrigerant storage area **625** that is in contact with the refrigerant passageway **620**, as illustrated. Additionally, the refrigerant storage area **625** has a storage access port **630**, which allows the compensator **600** to be connected to the refrigerant line **135** in a manner discussed above regarding FIG. **1**.

In this particular embodiment, the partitioning is accomplished by attaching a wall **635** having larger diameter to interior surfaces **645** of the housing **605** that essentially forms a cylindrical shape, but one that has a larger diameter than the either of the ports **610**, **615**. The wall **635** forms the storage area **625** about the perimeter of the wall **635** and the interior surface **640** of the housing **605**. Typically, the wall **635** will be welded to the interior surfaces **645** to form a seal between them. Though this particular embodiment presents a relatively straight refrigerant passageway, it is still an indirect refrigerant passageway because the larger diameter of the indirect refrigerant passageway **620** presents walls within the indirect refrigerant passageway **620** that result from the increased diameter of the passageway, which increases the heat transfer area of the compensator **600**.

FIG. **7** illustrates a sectional view of another embodiment of the compensator **160**. In this embodiment, the compensator **700** comprises a housing **705**, which is appropriately constructed of a material, such as metal, that can withstand the operating pressures of a heat pump system. The housing **705** is hollow and as an internal volume and further includes first and second ports **710**, **715** for allowing a passage of refrigerant through the housing **705**. The first and second ports **710**, **715** may either be exit ports or entry ports, depending on the operational mode of the heat pump system to which the compensator **700** is connected. The ports **710**, **715** may also have different configurations, depending on the embodiment. For example, in the illustrated embodiment, the ports **710**, **715** are separate connection nipples that are welded to an opening in the housing **705**, as shown in FIG. **7**.

In the embodiment of FIG. **7**, the internal volume is partitioned into an indirect refrigerant passageway **720** that extends through the housing **705**, and a refrigerant storage area **725** that is in contact with the indirect refrigerant passageway **720**, as illustrated. Additionally, the refrigerant storage area **725** has a storage access port **730**, which allows the compensator **700** to be connected to the refrigerant line **135** in a manner discussed above regarding FIG. **1**.

In this particular embodiment, the partitioning is accomplished by providing an irregular shaped wall **735** that may have a serpentine configuration, such as a spiral configuration or the corrugated configuration that is shown. The wall **735** is attached to interior surfaces **745** of the housing **705**. The wall **735** forms the storage area **725** between the perimeter of the wall **735** and the interior surface **740** of the housing **705**. Typically, the ends of the wall **735** will be welded to the interior surfaces **745** to form a seal between them. This particular embodiment presents another example of an indirect refrigerant passageway in that it includes a serpentine surface along the refrigerant path that increase the heat transfer surface of the compensator **700**.

The above disclosure illustrates examples of embodiments of the compensator as generally provided herein, and one that has a significant larger amount of heat transfer surface area, which improves the efficiency of the heat pump unit in which it may be employed. Further, these designs can easily be scaled for larger or smaller unit sizes.

Those skilled in the art to which this application relates will appreciate that other and further additions, deletions, substitutions and modifications may be made to the described embodiments.

What is claimed is:

1. A refrigerant charge compensator, comprising:

a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough, said internal volume being partitioned into an indirect refrigerant passageway that extends through said housing and first and second refrigerant storage areas being spaced apart,

a storage access port connected to each of said first and second refrigerant storage areas and said first and second refrigerant storage areas contacting said indirect refrigerant passageway, wherein said indirect refrigerant passageway comprises;

a volume separated from said first and second refrigerant storage areas and defined by a first wall attached to an interior surface of said housing and having an opening therethrough and a second wall attached to an interior surface of said housing and having an opening therethrough and spaced apart from said first wall, said volume being fluidly connected to a first refrigerant tube attached to said opening of said first wall and that extends outside of said housing through said first refrigerant storage area to provide said first port and a second refrigerant tube attached to said opening of said second wall and that extends outside of said housing through said second refrigerant storage area to provide said second port.

2. A refrigerant charge compensator comprising:

a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough, said internal volume comprising an indirect refrigerant passage way and a refrigerant storage area; and

a storage access port connected to said storage area, said storage area contacting said indirect refrigerant passageway, said indirect refrigerant passageway comprising;

a first indirect refrigerant passageway having a first wall attached to an interior surface of said housing and having an opening therethrough and second indirect refrigerant passageway having a second wall attached to an interior surface of said housing and having an opening therethrough and spaced apart from said first wall, said first indirect refrigerant passageway being fluidly connected to a first refrigerant tube that extends from said first indirect refrigerant passageway and outside of said housing to provide said first port and a second refrigerant tube that extends from said second indirect refrigerant passageway and outside of said housing to provide said second port, said first and second refrigerant passageways fluidly coupled by a tube that extends from said first wall, through said storage area, to said second wall.

3. A heat pump system, comprising:

a compressor, an inside heat exchanger in fluid connection with said compressor by a first refrigerant line;

an outside heat exchanger in fluid connection with said compressor by a second refrigerant line;

a compensator in fluid connection with said first refrigerant line and located between said inside heat exchanger and said compressor, said compensator, comprising, a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough, said internal volume being partitioned into an indirect refrigerant passageway that extends through said housing, and first and second spaced apart refrigerant storage areas,

a storage access port connected to each of said first and second spaced apart storage areas and said first and second spaced apart refrigerant storage areas contacting said indirect refrigerant passageway, wherein said indirect refrigerant passageway comprises;

a volume separated from said first and second refrigerant storage areas and defined by a first wall attached to an interior surface of said housing and having an opening therethrough and a second wall attached to an interior surface of said housing and having an opening therethrough and spaced apart from said first wall, said volume being fluidly connected to a first refrigerant tube attached to said opening of said first wall and that extends outside of said housing through said first refrigerant storage area to provide said first port and a second refrigerant tube attached to said opening of said second wall and that extends outside of said housing through said second refrigerant storage area to provide said second port; and

a third refrigerant flow line fluidly connecting said inside heat exchanger and said outside heat exchanger and having first and second bypass valves and thermal expansion valves connected thereto and located between said inside heat exchanger and said outside heat exchanger, said refrigerant storage area in fluid connection with said third refrigerant flow line through said storage access port.

4. A heat pump system, comprising:

a compressor, an inside heat exchanger in fluid connection with said compressor by a first refrigerant line;

an outside heat exchanger in fluid connection with said compressor by a second refrigerant line;

a compensator in fluid connection with said first refrigerant line and located between said inside heat exchanger and said compressor, said compensator, comprising,

a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough, said internal volume comprising an indirect refrigerant passage way and a refrigerant storage area; and

a storage access port connected to said storage area, said storage area contacting said indirect refrigerant passageway, said indirect refrigerant passageway comprising;

a first indirect refrigerant passageway having a first wall attached to an interior surface of said housing and having an opening therethrough and second indirect refrigerant passageway having a second wall attached to an interior surface of said housing and having an opening therethrough and spaced apart from said first wall, said first indirect refrigerant passageway being fluidly connected to a first refrigerant tube that extends from said first indirect refrigerant passageway and outside of said housing to provide said first port and a second refrigerant tube that extends from said second indirect refrigerant passageway and outside of said housing to provide said second port, said first and second refrigerant passageways fluidly coupled by a tube that extends from said first wall, through said storage area, to said second wall.

5. A refrigerant charge compensator, comprising:

a housing having an internal volume and first and second ports for allowing a passage of refrigerant therethrough, said internal volume being partitioned into an indirect refrigerant passageway that extends through said housing and a refrigerant storage area, said indirect refrigerant passageway defined by a wall attached to an interior surface of said housing, said indirect refrigerant passageway fluidly connected to a first tube that extends outside of said housing from said indirect refrigerant passageway to provide said first port and a second tube attached to said wall that extends through said storage area and extends outside of said housing to provide said second port; and

a storage access port connected to said refrigerant storage area.

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